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Genetic divergence and path co-efficient analysis in kala zeera (*Bunium persicum* Boiss. Fedtsch.)

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Abstract

Genetic variation and path coefficient analysis was carried out in seven genotypes of kala zeera (*Bunium persicum*). The genotypic, phenotypic and environmental correlations were calculated by applying the technique of variance-covariance analysis in which total variability was split into treatments, replication and error. The results indicated that the values of genotypic correlation coefficients were higher in general, than the phenotypic ones. Number of seed umbellet^{-1}, number of seed plant^{-1}, umbel diameter, number of secondary and tertiary branches plant^{-1}, number of umbellets umbel^{-1} and number of seed umbel^{-1} recorded significant positive association with seed yield ha^{-1} at the genotypic level. However, at phenotypic level, number of primary, secondary and tertiary branches plant^{-1}, umbel diameter, number of umbellets umbel^{-1}, number of umbels plant^{-1}, number of seed umbellet^{-1}, number of seed umbel^{-1}, number of seed plant^{-1} and 1000 seed weight were strongly associated with seed yield ha^{-1}. The characters such as number of umbels plant^{-1}, number of seed umbel^{-1}, umbel diameter and number of primary branches plant^{-1} contributed directly as well as indirectly in the expression of seed yield ha^{-1}. Residual effects was found to be significantly low (0.055) indicating that the number of primary branches plant^{-1} was the most reliable trait for improving the seed yield of *Bunium persicum* through selection.

Keywords: kala zeera, *Bunium persicum,* genetic diversity, path analysis

Kala zeera (*Bunium persicum* Boiss. Fedtsch.) is an economically important medicinal spice, condiment as well as aromatic plant belonging to family *Apiaceae*. It is perennial, glabrous, branched herb native to Europe and Western Asia and has been found growing in dry temperate areas in the Western Himalayan region of the Indian sub-continent at an altitude between 2000–3000 m above MSL and extending up to Baluchistan and Afghanistan (Bhartiya 1967). High altitude regions of Kinnaur, Lahul Spiti, Pangi, Bharmaur of Chamba area in Himachal Pradesh, Paddar valley, Gurez and Drass areas of Jammu &

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Kashmir are the potential areas of its production in India (Panwar *et al.* 1993). At present, crop is harvested only from the wild pockets by the local people and a little efforts to cultivate it as per improved agro-techniques have been made in Shong area of Kinnaur district of Himachal Pradesh with good economic returns. The plant is initially propagated through seed and subsequent regeneration is possible through tubers. Cultivation of kala zeera is quite remunerative as one hectare of crop yields net return of Rs. 13,680–1,05,277 between 4th–10th year of its establishment. Keeping in view the importance of the species, its use in ayurvedic formulations and being in the endangered category, its conservation, promotion of cultivation and yield improvement is the need of the hour. This requires evaluation and screening of germplasm to select elite material. The present study was, therefore, undertaken to find the correlation among growth and yield traits and path coefficient analysis in kala zeera collections from its natural zone of occurrence to develop high yielding cultivars.

A field experiment was conducted during 2007–08 at Potato Farm, Nathatop, Government of Jammu and Kashmir. The experiment was laid out in a Randomized Block Design comprising of seven treatments of collections of kala zeera from different sources (from Jammu & Kashmir and Himachal Pradesh) with three replications. Healthy tubers were planted in the plots of size 1 m × 1.5 m with spacing of 25 cm × 15 cm. The tubers were sown on 15th November 2007 before the snowfall. The experimental site was located at an altitude of 2533 m MSL with average maximum temperature of 28°C and annual rainfall of 900 mm. Soil at the site was neutral in reaction with optimum ranges of available nitrogen, phosphorus and potassium. Data on various growth and morphological characters was recorded on five randomly selected plants per replication in each genotype in May–June 2008. The crop was harvested in the 2nd week of July 2008. The genotypic, phenotypic and environmental correlation was calculated by applying the technique of variance and co-variance analysis in which total variability is split into treatment, replication and error components. The direct and indirect path effects were obtained by employing the method followed by Dewey & Lu (1959).

The genotypic, phenotypic and environmental correlation coefficients for growth and yield contributing characters *viz*., plant height, number of primary branches plant^{-1}, number of secondary branches plant^{-1}, number of tertiary branches plant^{-1}, number of leaves plant^{-1}, number of umbellets umbel^{-1}, number of umbels plant^{-1}, umbel diameter, number of seed umbellet^{-1}, number of seed umbel^{-1}, number of seed plant^{-1}, seed yield ha^{-1} and 1000-seed weight are presented in Table 1. The genotypic correlation coefficients were lower as compared to the phenotypic values. Out of total 78 combinations, 32 combinations showed significant positive correlation whereas, plant height vs number of umbellets/ umbel and number of umbels plant^{-1} vs number of seed umbellet^{-1} exhibited significant negative correlation. Number of umbellets umbel^{-1}, number of tertiary branches plant^{-1}, umbel diameter, 1000-seed weight, number of seed plant^{-1}, number of umbels plant^{-1}, seed yield, number of seed umbellet^{-1}, number of seed umbel^{-1}, number primary branches plant^{-1} and number of secondary branches plant^{-1} showed significant positive correlations among themselves. These characters also showed high heritability coupled with moderately high genetic gains, thus indicating additive genetic components present in them. Therefore, selection is the most suitable method for the improvement of these traits to get desired high seed yield ha^{-1} and all these characters can be exploited for getting desired improvement in seed yield ha^{-1}. Similar findings have also been reported by Panwar & Badiyala (1990); Singh & Kaith (1990); Chauhan *et al.* (2006) and Chauhan (2003) in kala zeera.

At the phenotypic level, out of total 78 combinations, 39 were found to have significant positive association with each other. The characters *viz*., number of umbels plant^{-1}, seed yield ha^{-1}, 1000-seed weight, number of seed plant^{-1}, number of umbels plant^{-1}, number of seed umbel^{-1}, number of seed umbellet^{-1}, number

Table 1. Genotypic, phenotypic and environmental correlation coefficients between different characters in kala zeera

Characters		Plant height (cm)	Number of primary branches plant^{-1}	Number of secondary branches plant^{-1}	Number of tertiary branches plant^{-1}	Number of leaves plant^{-1}	Umbel diameter (cm)	Number of umbellets umbel^{-1}	Number of umbels plant^{-1}	Number of seed umbellet^{-1}	Number of seed umbel^{-1}	Number of seed plant^{-1}	1000 seed weight (g)	Seed yield (kg ha^{-1})
Plant height (cm)	G	1.000	0.423	0.387	-0.333	0.392	0.470**	-0.595*	0.084	0.366	0.236	-0.015	0.122	0.076
	P	1.000	0.385	0.223	-0.370	0.137	0.326	-0.222	0.056	0.241	0.179	0.023	0.055	0.087
	E	1.000	0.309	-0.223	-0.479**	-0.051	0.067	0.053	-0.029	0.160	0.136	0.085	0.257	0.139
Number of primary branches plant^{-1}	G		1.000	0.047	0.704**	0.936*	0.034	0.874*	0.065	0.034	0.057	0.161	0.010	0.076
	P		1.000	0.768**	0.502**	0.568*	0.545**	0.279	0.697*	0.276	0.517	0.524**	0.732**	0.686*
	E		1.000	0.146	0.039	0.392	-0.221	-0.123	-0.125	-0.354	-0.288	-0.320	-0.183	-0.200
Number of secondary branches plant^{-1}	G			1.000	0.814*	0.014	0.831**	0.451**	0.942**	0.070	0.156	0.074	0.853*	0.955*
	P			1.000	0.612*	0.460**	0.605*	0.273	0.707*	0.411	0.638	0.168*	0.721*	0.733*
	E			1.000	-0.004	0.081	0.174	0.186	-0.072	-0.231	-0.326	-0.116	0.134	-0.679
Number of tertiary branches plant^{-1}	G				1.000	0.980*	0.675*	0.990*	0.969*	0.760*	0.874*	0.054	0.821*	0.948*
	P				1.000	0.438	0.347	0.342	0.616*	0.298	0.551	0.597*	0.738*	0.650*
	E				1.000	0.057	-0.324	-0.191	-0.596*	-0.161	-0.057	-0.162	0.384	-0.536*
Number. of leaves plant^{-1}	G					1.000	0.172	0.063	0.317	0.980*	0.318	0.440	0.284	0.314
	P					1.000	0.541**	0.214	0.461**	0.126	0.341	0.389	0.513**	0.478
	E					1.000	0.192	-0.051	-0.252	-0.546	-0.235	-0.171	-0.277	-0.361
Umbel diameter (cm)	G						1.000	0.619*	0.894*	0.155	0.979*	0.003	0.981*	0.892*
	P						1.000	0.246	0.701	0.330	0.429	0.474**	0.633*	0.688*
	E						1.000	0.025	0.322	-0.284	-0.303	-0.149	-0.378	0.230
Number of umbellets umbel^{-1}	G							1.000	0.251	0.304	0.436	0.705*	0.039	0.968*
	P							1.000	0.371	0.093	0.208	0.690*	0.594*	0.594*
	E							1.000	-0.435	0.015	0.083	0.724*	0.401	0.484**
Number of umbels plant^{-1}	G								1.000	-0.836*	0.956*	0.215	0.177	0.040
	P								1.000	0.411	0.557	0.621*	0.852	0.925*
	E								1.000	0.062	-0.255	-	0.198	0.387
Number of seed umbellet^{-1}	G									1.000	0.197	0.925*	0.747*	0.817*
	P									1.000	0.821*	0.661*	0.441	0.539**
	E									1.000	0.717	-	0.196	0.400
Number of seed umbel^{-1}	G										1.000	0.948*	0.818*	0.902*
	P										1.000	0.847*	0.618*	0.725*
	E										1.000	0.736*	0.180	0.398
Number of seed plant^{-1}	G											1.000	0.032	0.065
	P												0.788*	0.860*
	E												0.418	0.609*
1000 seeds weight (g)	G												1.000	0.024
	P												1.000	0.916*
	E												1.000	0.088
Seed yield (kg ha^{-1})	G													1.000
	P													1.000
	E													1.000

*Significant @ 5%; **Significant at 1%; G=genotypic correlation coefficient; P=phenotypic correlation coefficient; E=environmental correlation coefficient of primary, secondary and tertiary branches plant^{-1} have recorded significant positive correlations. Thus, these yield contributing characters having strong inter-relationships with other characters which can be effectively considered for their inter-dependence in their expression. The results are in line with those of Martin & Cabanillas (1967) in *Dioscorea floribunda*; Verma (1989) in *Glaucium flavum*; Singh & Kaith (1990); Panwar & Badiyala (1990); Chauhan (2003) in kala zeera and Rastogi (1993) in Swertia.

The environmental correlation co-efficient was in general of low order for almost all the character combinations. This indicated the minimal influence of environmental on the expression of these characters but some effect on association of these characters cannot be ruled out. The reports of Maurya & Sinha (1989) in fenugreek; Singh & Kaith (1990); Panwar & Badiyala (1990) and Chauhan (2003) in kala zeera; Rastogi (1993) in Swertia and Verma (1994) in *Valeriana jatamansi* are comparable with the present investigation. This suggested that plant with more number of primary, secondary and tertiary branches plant^{-1}, number of umbels plant^{-1}, number of umbellets umbel^{-1}, umbel diameter, number of seed umbellet^{-1}, number of seed umbel^{-1}, number of seed plant^{-1} should be considered for further improvement in seed yield.

The path co-efficient analysis was used to understand the direct and indirect causes by partitioning correlation co-efficient into the components of direct and indirect effects (Table 2). In the present study the residual effect was significantly low (i.e. 0.055) indicating the adequacy of the characters chosen for seed yield ha^{-1} of *Bunium persicum*. The genotypic model depicted that the traits selected accounted for more than 99% of the genetic variability. The path coefficient analysis revealed that characters like plant height, number of primary branches plant^{-1}, number of tertiary branches plant^{-1}, umbel diameter, number of umbels plant^{-1}, number of seed plant^{-1} had positive direct effect on seed yield, whereas, number of secondary branches plant^{-1}, number of leaves plant^{-1}, number of umbellets umbel^{-1}, number of seed umbellet^{-1}, number of seed umbel^{-1}, 1000 seed weight had negative direct effect on seed yield ha^{-1}. In addition these characters *viz*., number of primary branches plant^{-1}, number of tertiary branches plant^{-1}, umbel diameter and number of seed plant^{-1}, the value of path coefficient (direct effect) is almost equal to the total effect (genotypic correlation). It may be concluded that these characters are sufficient to bring improvement in seed yield ha^{-1} of *Bunium persicum*. The present investigation, therefore, revealed that for the improvement of seed yield in *Bunium persicum*, characters like number of number of primary branches plant^{-1}, number of tertiary branches plant^{-1}, umbel diameter and number of seed plant^{-1} need greater emphasis in selection. These results are similar to the findings of Rao *et al.* (1981) in coriander, Rishi *et al.* (1984) in *Dioscorea deltoidea*, Sharma *et al.* (1990) in *Digitalis lanata* and Devi (2004) in kala zeera.

In brief, the number of primary branches plant^{-1} had the highest indirect effect through number of tertiary branches plant^{-1}, umbel diameter, number of umbels plant^{-1}, and number of seed plant^{-1}. It is therefore, concluded that primary branches plant^{-1} is the most reliable character on which the selection should be based. However, other characters *viz*., tertiary branches plant^{-1}, umbel diameter, number of umbellets plant^{-1} may also be considered for selection to get desired yield improvement in *Bunium persicum.*

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Table 2. Direct and indirect effect of different characters on seed yield (kg ha^{-1}) in kala zeera

Characters	Plant height (cm)	Number of primary branches $plant^{-1}$	Number of secondary branches $plant^{-1}$	Number of tertiary branches $plant^{-1}$	Number of leaves $plant^{-1}$	Umbel diameter (cm)	Number of umbellets $umbel^{-1}$	Number of umbels $plant^{-1}$	Number of seed $umbellet^{-1}$	Number of seed $umbel^{-1}$	Number of seed $plant^{-1}$	1000 seed weight (g)	Genotype correlation with seed yield
Plant height (cm)	**0.579**	0.028	-0.140	-0.202	-0.038	0.163	0.277	0.198	-0.016	-0.404	-0.050	-.256	0.076
Number of primary branches $plant^{-1}$	0.245	**0.066**	-0.378	0.428	-0.894	0.358	-0.407	0. 503	-0.044	-0.811	0.754	-0.629	0.076
Number of secondary branches $plant^{-1}$	0.224	0.069	**-0.361**	0.495	-0.097	0.288	-0.210	0..214	-0.046	-0.981	0.472	-0.221	0.955*
Number of tertiary branches $plant^{-1}$	-0.193	0.047	-0.294	**0.608**	-0.094	0.234	-0.461	0.276	-0.032	-0.498	0.409	-0.197	0.948*
Number of leaves $plant^{-1}$	0.227	0.062	-0.366	0.596	**-0.096**	0.406	-0.495	0.096	-0.084	-0.259	0.656	-0.432	0.314
Umbel diameter (cm)	0.272	0.069	-0.300	-0.410	-0.112	**0.346**	-0.289	0.101	-0.049	-0.678	0.234	-0.009	0.892*
Number of umbellets $umbel^{-1}$	-0.345	0.058	-0.163	0.602	-0.102	0.215	**-0.466**	0.941	-0.013	-0.748	0..281	-0.263	0.968*
Number of umbels $plant^{-1}$	0.049	0.071	-0.340	0.589	-0.126	0.310	-0.583	**0.350**	-0.036	-0.639	0..927	-0.508	0.040
Number of seeds $umbellet^{-1}$	0.212	0.069	-0.386	0.462	-0.189	0.400	-0.142	0.964	**-0.043**	-0.768	0..989	-0.754	0.817*
Number of seeds $umbel^{-1}$	0.137	0.070	-0.417	0.531	-0.126	0.339	-0.203	0.247	-0.044	**-0.714**	0..065	-0.043	0.902*
Number of seeds $plant^{-1}$	-0.009	0.077	-0.387	0.641	-0.138	0.346	-0.329	0.854	-0.039	-0.624	**0..234**	-0.591	0.065
1000-seed weight (g)	0.044	0.071	-0.345	0.576	-0.126	0.309	-0.451	0.444	-0.035	-0.546	0.443	**-0.372**	0.024

*, **Significant at 5% and 1% respectively; Residual effect=0.055

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